

## SYNERGISTIC QUINCLORAC HERBICIDAL COMPOSITIONS

### Field of the Invention

The present invention relates to a selective synergistic postemergent herbicidal composition for the control of undesired vegetation when applied to the locus of the vegetation. Quinclorac, 3,7-dichloro-8-quinolinecarboxylic acid (CAS 84087-01-4), certain protoporphyrinogen oxidase inhibitors, herein referred to as "protox inhibitors," and a number of herbicidal auxinic agents have been used individually for selective control of noxious weeds and plants without significant damage to desirable grasses and the like. Heretofore, it had not been recognized that when quinclorac is combined with a protox inhibitor or a protox inhibitor plus herbicidal auxinic compound in certain relative proportions, the combination exhibits an unexpected synergistic herbicidal effect providing more effective control of difficult to eradicate grassy weeds and undesirable broadleaf vegetation than the individual herbicidal materials used alone at comparable application rates.

Protox inhibitors that exhibit herbicidal synergistic effects in combination with quinclorac include carfentrazone-ethyl (CAS 128639-02-1), sulfentrazone (CAS 122836-35-5), and pyraflufen-ethyl, 2-chloro-5-(4-chloro-5-difluoromethoxy-1-methylpyrazol-3-yl)-4-fluorophenoxyacetic acid ester (CAS 129630-17-7). Protox inhibitors has been found to synergize the herbicidal effectiveness of a number of herbicidal auxinic agents including herbicidally active phenoxy, benzoic, pyridine, quinolinecarboxylic acid compounds, other than quinclorac, and amine and inorganic salts thereof.

### Background of the Invention

Herbicidal auxenic compounds have been used for many years to control broadleaf noxious weeds without damage to desirable grasses infested with the weeds. 2,4-D, 2,4-DP, 2,4-DB, MCPP, MCPA, MCPB, which are exemplary herbicidal auxinic compounds, have all been registered and long used individually or in combination as herbicides for treating turf to control undesirable broadleaf vegetation without significantly adversely affecting desirable grasses. Similarly, herbicidal protox

inhibitors such as carfentrazone-ethyl, sulfentrazone, and pyraflufen-ethyl have in recent years been used to control undesirable broadleaf vegetation. Although auxinic and protox inhibitor compounds as described have individually been found to be effective in broadleaf weed control without significant damage to desirable grasses, these compounds have not been known to be effective for control of grassy weeds, such as crabgrass, goosegrass and dahlisgrass.

Thus, there continues to be a need for increasing the herbicidal effectiveness of exemplary herbicidal protox inhibitors and herbicidal auxinic compounds, which have heretofore been used alone or in combination, and especially to provide a herbicidal composition that will not only control noxious broadleaf vegetation, but also be effective against grassy weeds without adversely effecting desirable grasses. The urgency of the need is exacerbated by increasing governmental oversight of the sale and approved use rate of herbicidal materials. The recommended level of herbicide that may be applied per unit of area is under pressure from governmental, as well as for economic and environmental reasons.

In addition, certain species of undesirable broadleaf vegetation and grassy weeds are becoming more and more resistant to a number of the most widely used herbicides. Thus, on one hand ever more stringent conditions are being placed on the type and use rate of herbicides, while on the other hand accepted herbicides are becoming less and less effective over time in certain species of noxious weeds.

Furthermore, it is very expensive and time consuming to seek and obtain registration of a new herbicidal compound, including its proposed use rate. Approval data required must not only include evidence of efficacy at the application rates proposed but also the safety of the herbicide when applied at the recommended level. Accordingly, demonstration of synergism by the combination of existing herbicidal agents, permits use of the individual components of the synergistic combination at lower rates than when used alone, and in many instances ameliorates increasing resistance to herbicidal effectiveness.

Accordingly, there is a great need for improved broadleaf and grassy weed control compositions and a method of controlling such noxious vegetation without

adversely affecting desirable plants and which reduces the amount of chemical herbicidal agent necessary to obtain the acceptable weed control.

#### Brief Summary of the Invention

5           This invention relates to the discovery that when quinclorac, a herbicidal protox inhibitor and a herbicidal auxinic agent are combined, the resulting combination exhibits synergistic herbicidal effects, which are equal to or better than the herbicidal efficacy of the individual herbicides, even though each of the constituents is present at a lower concentration than the required amount of each herbicide applied alone.

10           In particular, tests have shown that when quinclorac, a herbicidal protox inhibitor and an auxinic herbicide agent are combined, and the resulting composition is applied at a recommended application rate for control of undesired broadleaf vegetation and grassy weeds, a demonstrable synergistic effect is obtained. It has unexpectedly been found that when a protox inhibitor is combined with quinclorac, the  
15           combination containing a lesser amount of quinclorac than recommended as a single herbicidal agent, not only exhibits more effective control of broadleaf weeds, but in addition this combination provides better control of grassy weeds than when quinclorac is applied alone, all without significant damage to desirable turf and grasses. This synergistic effect in controlling broadleaf noxious vegetation as well as grassy weeds  
20           is enhanced even more by the addition of an auxinic compound.

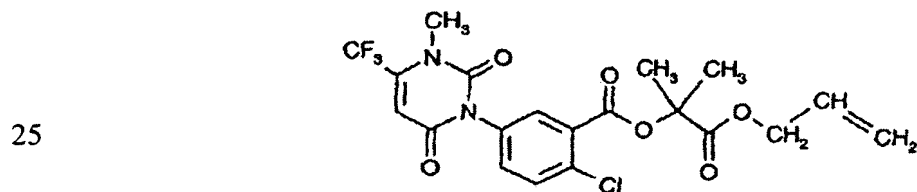
          The selective synergistic postemergent herbicidal composition for the control of undesired vegetation when applied at a recommended application rate to the locus of undesired vegetation includes from about 0.1 to about 1 lb/acre of quinclorac and from about 0.005 to about 0.06 lb/acre of a selective protox herbicidal inhibitor. Better  
25           results are obtained when the amount of quinclorac is supplied at a rate of about 0.18 to about 0.75 lb/acre and a sufficient amount of the protox inhibitor is provided at a rate of about 0.01 to about 0.05 lb/acre. Best results are obtained when a sufficient amount of quinclorac is provided to supply about 0.375 lb/acre of quinclorac. Similarly, better results are obtained when the amount of the protox inhibitor is  
30           sufficient to supply from about 0.01 to about 0.05 lb/acre, and best results are obtained

when the protox inhibitor provided is sufficient to supply from about 0.02 to about 0.03 lb/acre.

Synergistic results are preferably obtained by providing a sufficient amount of the active herbicidal ingredients to supply from about 0.1 to about 1 lb/acre of quinclorac, from about 0.005 to about 0.06 lb/acre of the protox inhibitor and from  
5 about 0.15 to about 2 lbs/acre of the auxinic compound.

Improved synergism is obtained between the quinclorac, the protox inhibitor and the auxinic herbicide agent when a sufficient amount of the active ingredients is provided to supply from about 0.18 to about 0.75 lb/acre of quinclorac, from about 0.01  
10 to about 0.05 lb/acre of the protox inhibitor, and from about 0.25 to about 1.5 lbs/acre of the auxinic herbicide. Best synergistic results obtain by combining sufficient quinclorac, protox inhibitor and auxinic herbicide when the composition contains an amount of the active ingredients to provide about 0.375 lb/acre of the quinclorac, from about 0.02 to about 0.03 lb/acre of the protox inhibitor, and about 0.75 lb/acre of the  
15 auxinic herbicide.

Exemplary protox inhibitors useful in the present invention include carfentrazone-ethyl, sulfentrazone, pyraflufen-ethyl, flumiclorac-pentyl, flumioxazin, fluthiacet-methyl, aclonifen, bifenox, chlornitrophen, ethoxyfen, fluoroglycofen-ethyl, fomesafen, lactofen, oxyfluorfen, azafendin, cinidon-ethyl, oxadiargyl, oxadiazon,  
20 pentoxazone, flumipropyn, flupropacil, benzfendizone, nipyraclufen, fluazolate, thidiazimin or a compound having the structural formula



or combinations thereof.

The auxinic herbicidal agent may comprise one or more compounds selected  
30 from the group consisting of herbicidally active phenoxy, benzoic, pyridine, quinolinecarboxylic acid compounds, other than quinclorac, and amine, esters and

inorganic salts thereof. The salts are preferably selected from a group consisting of, but are not limited to, methylamine, ethylamine, isopropylamine, monomethanolamine, monoethanolamine, monoisopropanolamine, dimethylamine, diethylamine, diisopropylamine, dimethanolamine, diethanolamine, diisopropanolamine, trimethylamine, triethylamine, tri-isopropylamine, trimethanolamine, triethanolamine, triisopropanolamine, and ammonium, sodium, potassium, lithium, calcium salts of the above acids are also useful. The auxinic herbicidal acidic compounds may be selected from a group consisting of 2,4-dichlorophenoxyacetic acid (2,4-D), 2,4-dichlorophenoxypropionic acid (2,4-DP), 2,4-dichlorophenoxybutyric acid (2,4-DB), 2-methyl-4-chlorophenoxyacetic acid (MCPA), 2-methyl-4-chlorophenoxypropionic acid (MCPP), 2-methyl-4-chlorophenoxybutyric acid, 2,4,5-trichlorophenoxyacetic acid, 2,3,6-trichlorobenzoic acid, 3,6-dichloro-2-methoxybenzoic acid (dicamba), 2-methoxy-3,5,6-trichlorobenzoic acid, 4-chloro-2-oxobenzothiazolin-3-ylacetic acid, 4-amino-3,5,6-trichloropicolinic acid, trichloroacetic acid, 2,2-dichloropropionic acid, 3-amino-2,5-dichlorobenzoic acid, methane arsonic acid, 2,3,6-trichlorophenylacetic acid, 3,6-endoxohexahydrophthalic acid, 3,5,6-trichloro-4-aminopicolinic acid, 7-chloro-3-methyl-8-quinolinecarboxylic acid, ((4-amino-3,5-dichloro-6-fluoro-2-pyridinyl)oxy)acetic acid, 3,4,6-trichloro-2-pyridinyloxyacetic acid, 3,6-dichloro-2-pyridinecarboxylic acid, and 1-methylheptyl ester. Ester forms of the auxinic herbicidal agents include carbon chain lengths, either linear or branched, in which from C<sub>1</sub> to C<sub>20</sub> are present.

#### Detailed Description of the Invention

The synergistic composition of this invention resulting from the combination of quinclorac, a herbicidal protox inhibitor and an auxinic herbicide as active agents normally would include any one of a number of well known inert ingredients, depending upon the nature of the product commercialized. Preferred synergistic formulations are as follows.

## Example 1

	<u>Active Ingredient</u>	<u>Percent of Active Ingredient in Formulation</u>
	Quinclorac	4.3%
	Sulfentrazone	0.3%
5	2,4D	8.6%

## Example 2

	<u>Active Ingredient</u>	<u>Percent of Active Ingredient in Formulation</u>
	Quinclorac	4.3%
10	Carfentrazone-ethyl	0.2%
	MCPA	12%

## Example 3

	<u>Active Ingredient</u>	<u>Percent of Active Ingredient in Formulation</u>
15	Quinclorac	4.3%
	Sulfentrazone	0.3%
	MCPA	12%

20 The quinclorac content of the formulation is from about 1.0% to about 11.5 %, more particularly from about 1.8% to about 4%, and preferably 4.3%. The carfentrazone-ethyl, sulfentrazone or pyraflufen-ethyl is from about 0.005% to about 0.06%, more particularly from about 0.01% to about 0.05%, and preferably from about 0.02% to about 0.03%. The auxinic herbicide is present in the formulation from about 1.7% to about 22.2%, more particularly from about 2.8% to about 16.3%, and  
 25 preferably about 8.6%.

## Greenhouse Tests

30 Pots of crabgrass, dandelion, white clover, and plantain grown in greenhouse soiless growth media were sprayed with a greenhouse pot sprayer at 43.46 gallons of spray solution/acre and allowed to stand in the greenhouse. Visual observation of the effects made by the herbicidal compositions on the plants in the test pots was recorded for control of crabgrass, dandelion, clover and plantain at 24 hours after treatment (HAT), 48 hours after treatment (HAT), 72 hours after treatment (HAT), 7 days after

treatment (DAT), 14 days after treatment (DAT) and 21 days after treatment (DAT). A control rating scale of 1 to 9 was used to record the visual observation of the effect of the herbicidal composition on the plants over the time period of the tests. 1 = no control, and 9 = death of plant, with intervening numbers representing successive  
 5 degrees of observed effectiveness of the herbicidal composition over time. The 1 - 9 control rating scale was converted to percent control in the test data charts that follow.

The test protocol of S.R. Colby as set out in his article entitled "Calculating Synergistic and Antagonistic Responses of Herbicide Compositions," received for publication April 11, 1966, Contribution No. 3796 and Scientific Article No. 1271 of  
 10 the Maryland Agricultural Experiment Station, Department of Agronomy, University of Maryland was followed to evaluate the synergistic properties of the combination of quinclorac plus a herbicidal protox inhibitor, and a combination of quinclorac, plus a herbicidal protox inhibitor plus a herbicidal auxinic agent as compared with the individual herbicides, using Colby's formulas  $E = X + Y - XY/100$  for a two herbicide  
 15 combination, where E = the expected percent of inhibition of growth by herbicides, X = the percent inhibition of growth by herbicide A at p lb/A, and Y = the percent inhibition of growth by herbicide B at q lb/A, for a given combination of two herbicides. Colby's formula  $E = X + Y + Z - (XY + XZ + YZ)/100 + XYZ/10,000$ , was used for the three-way herbicide combination evaluation, where E, X and Y are the  
 20 same as in the two herbicide formula and Z = the percent inhibition of growth by the third herbicide.

It is recognized in the herbicide field that control of grassy weeds such as crabgrass can be obtained only over a time period of 10 to 14 days, whereas with the present synergistic combination, crabgrass control is obtained in as little as seven days  
 25 as demonstrated by the test data set forth below.

Test 1	Control (1-9) 24 HA			% Control 24 HAT			Treatment	
	Crabgrass	Dandelion	Clover	Crabgrass	Dandelion	Clover		
2	1	1	1	22.2	11.1	11.1	Quinclorac @ 0.75 lbs/A	
2	1	1	1	22.2	11.1	11.1	Quinclorac @ 0.375 lbs/A	
2	2	1	1	22.2	22.2	11.1	Quinclorac @ 0.18 lbs/A	
3	3	3	3	33.3	33.3	33.3	Carfentrazone @ 0.02 lbs/A	
2	4	3	3	22.2	44.4	33.3	Carfentrazone @ 0.01 lbs/A	
2	3	1	1	22.2	33.3	11.1	2,4-D IOE @ 0.70 lbs/A	
4	4	4	4	44.4	44.4	44.4	0.75 Quinclorac + 0.02 Carfentrazone	
4	4	4	4	44.4	44.4	44.4	0.75 Quinclorac + 0.01 Carfentrazone	
3	4	3	3	33.3	44.4	33.3	0.375 Quinclorac + 0.02 Carfentrazone	
3	3	3	3	33.3	33.3	33.3	0.375 Quinclorac + 0.01 Carfentrazone	
3	5	4	4	44.4	55.6	44.4	0.18 Quinclorac + 0.02 Carfentrazone	
4	4	4	4	44.4	44.4	44.4	0.18 Quinclorac + 0.01 Carfentrazone	
5	5	4	4	44.4	55.6	44.4	0.75 Quinclorac + 0.02 Carfentrazone + 0.70 2,4-D IOE	
5	5	4	4	55.6	55.6	44.4	0.75 Quinclorac + 0.01 Carfentrazone + 0.70 2,4-D IOE	
5	5	4	4	44.4	55.6	44.4	0.375 Quinclorac + 0.02 Carfentrazone + 0.70 2,4-D IOE	
4	4	4	4	44.4	44.4	44.4	0.375 Quinclorac + 0.01 Carfentrazone + 0.70 2,4-D IOE	

Crabgrass		Dandelion		Clover	
Expected	Actual	Expected	Actual	Expected	Actual
48.1	44.4	40.7	44.4	40.7	44.4
39.5	44.4	50.6	44.4	40.7	44.4
48.1	33.3	40.7	44.4	40.7	33.3
39.5	33.3	50.6	33.3	40.7	33.3
48.1	33.3	48.1	55.6	40.7	44.4
39.5	44.4	56.8	44.4	40.7	44.4
59.7	55.6	60.5	55.6	47.3	44.4
52.9	55.6	67.1	55.6	47.3	44.4
59.7	55.6	60.5	55.6	47.3	44.4
52.9	44.4	67.1	44.4	47.3	44.4



Test 1 Control (1-9) 48 H				% Control 48 HAT		Treatment	
Crabgrass	Dandelion	Clover	Crabgrass	Dandelion	Clover		
4	3	3	44.4	33.3	33.3	Quinclorac @ 0.75 lbs/A	
4	3	3	44.4	33.3	33.3	Quinclorac @ 0.375 lbs/A	
3	3	2	33.3	33.3	22.2	Quinclorac @ 0.18 lbs/A	
5	5	5	55.6	55.6	55.6	Carfentrazone @ 0.02 lbs/A	
3	5	5	33.3	55.6	55.6	Carfentrazone @ 0.01 lbs/A	
4	4	4	44.4	44.4	44.4	2,4-D IOE @ 0.70 lbs/A	
5	6	6	55.6	66.7	66.7	0.75 Quinclorac + 0.02 Carfentrazone	
6	7	7	66.7	77.8	77.8	0.75 Quinclorac + 0.01 Carfentrazone	
5	7	7	55.6	77.8	77.8	0.375 Quinclorac + 0.02 Carfentrazone	
7	7	7	77.8	77.8	77.8	0.375 Quinclorac + 0.01 Carfentrazone	
7	8	7	77.8	88.9	77.8	0.18 Quinclorac + 0.02 Carfentrazone	
7	7	7	77.8	77.8	77.8	0.18 Quinclorac + 0.01 Carfentrazone	
8	8	7	88.9	88.9	77.8	0.75 Quinclorac + 0.02 Carfentrazone + 0.70 2,4-D IOE	
8	8	8	88.9	88.9	88.9	0.75 Quinclorac + 0.01 Carfentrazone + 0.70 2,4-D IOE	
7	7	7	77.8	77.8	77.8	0.375 Quinclorac + 0.02 Carfentrazone + 0.70 2,4-D IOE	
7	6	7	77.8	66.7	77.8	0.375 Quinclorac + 0.01 Carfentrazone + 0.70 2,4-D IOE	

Crabgrass		Dandelion		Clover	
Expected	Actual	Expected	Actual	Expected	Actual
75.3	55.6	70.4	66.7	70.4	66.7
63.0	66.7	70.4	77.8	70.4	77.8
75.3	55.6	70.4	77.8	70.4	77.8
63.0	77.8	70.4	77.8	70.4	77.8
70.4	77.8	70.4	88.9	65.4	77.8
55.6	77.8	70.4	77.8	65.4	77.8
86.3	88.9	83.5	88.9	83.5	77.8
79.4	88.9	83.5	88.9	83.5	88.9
86.3	77.8	83.5	77.8	83.5	77.8
79.4	77.8	83.5	66.7	83.5	77.8

Test 1 Control (1-9) 7 DAT			% Control 7 DAT			Treatment	
Crabgrass	Dandelion	Clover	Plantain	Crabgrass	Dandelion	Clover	Plantain
4	3	3	3	44.4	33.3	33.3	Quinclorac @ 0.75 lbs/A
4	3	3	3	44.4	33.3	33.3	Quinclorac @ 0.375 lbs/A
4	3	3	3	44.4	33.3	33.3	Quinclorac @ 0.18 lbs/A
7	8	6	6	77.8	88.9	66.7	Carfentrazone @ 0.02 lbs/A
7	8	6	6	77.8	88.9	66.7	Carfentrazone @ 0.01 lbs/A
4	6	4	4	44.4	66.7	44.4	2,4-D IOE @ 0.70 lbs/A
8	8	8	8	88.9	88.9	88.9	0.75 Quinclorac + 0.02 Carfentrazone
8	8	8	8	88.9	88.9	88.9	0.75 Quinclorac + 0.01 Carfentrazone
8	8	8	8	88.9	88.9	88.9	0.375 Quinclorac + 0.02 Carfentrazone
8	8	8	8	88.9	88.9	88.9	0.375 Quinclorac + 0.01 Carfentrazone
8	9	8	8	88.9	100.0	88.9	0.18 Quinclorac + 0.02 Carfentrazone
8	9	8	8	88.9	100.0	88.9	0.18 Quinclorac + 0.01 Carfentrazone
8	9	8	8	88.9	100.0	88.9	0.75 Quinclorac + 0.02 Carfentrazone + 0.70 2,4-D IOE
8	9	8	8	88.9	100.0	88.9	0.75 Quinclorac + 0.01 Carfentrazone + 0.70 2,4-D IOE
8	9	8	8	88.9	100.0	88.9	0.375 Quinclorac + 0.02 Carfentrazone + 0.70 2,4-D IOE
8	9	8	8	88.9	100.0	88.9	0.375 Quinclorac + 0.01 Carfentrazone + 0.70 2,4-D IOE

Crabgrass		Dandelion		Clover	
Expected	Actual	Expected	Actual	Expected	Actual
87.7	88.9	92.6	88.9	77.8	88.9
87.7	88.9	92.6	88.9	77.8	88.9
87.7	88.9	92.6	88.9	77.8	88.9
87.7	88.9	92.6	88.9	77.8	88.9
87.7	88.9	92.6	100.0	77.8	88.9
87.7	88.9	92.6	100.0	77.8	88.9
93.1	88.9	97.5	100.0	87.7	88.9
93.1	88.9	97.5	100.0	87.7	88.9
93.1	88.9	97.5	100.0	87.7	88.9
93.1	88.9	97.5	100.0	87.7	88.9

Test 1		Control (1-9) 14 DAT				% Control 14 DAT				Treatment	
Crabgrass	Dandelion	Clover	Plantain	Crabgrass	Dandelion	Clover	Plantain				
5	6	8		55.6	66.7	88.9		Quinclorac @ 0.75 lbs/A			
5	7	9		55.6	77.8	100.0		Quinclorac @ 0.375 lbs/A			
7	8	9		77.8	88.9	100.0		Quinclorac @ 0.18 lbs/A			
3	9	9		33.3	100.0	100.0		Carfentrazone @ 0.02 lbs/A			
3	8	7		33.3	88.9	77.8		Carfentrazone @ 0.01 lbs/A			
3	9	8		33.3	100.0	88.9		2,4-D IOE @ 0.70 lbs/A			
8	9	9		88.9	100.0	100.0		0.75 Quinclorac + 0.02 Carfentrazone			
8	9	9		88.9	100.0	100.0		0.75 Quinclorac + 0.01 Carfentrazone			
7	9	9		77.8	100.0	100.0		0.375 Quinclorac + 0.02 Carfentrazone			
6	9	9		66.7	100.0	100.0		0.375 Quinclorac + 0.01 Carfentrazone			
6	9	8		66.7	100.0	88.9		0.18 Quinclorac + 0.02 Carfentrazone			
7	9	8		77.8	100.0	88.9		0.18 Quinclorac + 0.01 Carfentrazone			
7	9	9		77.8	100.0	100.0		0.75 Quinclorac + 0.02 Carfentrazone + 0.70 2,4-D IOE			
8	9	9		88.9	100.0	100.0		0.75 Quinclorac + 0.01 Carfentrazone + 0.70 2,4-D IOE			
8	9	9		88.4	100.0	100.0		0.375 Quinclorac + 0.02 Carfentrazone + 0.70 2,4-D IOE			
8	9	9		88.9	100.0	100.0		0.375 Quinclorac + 0.01 Carfentrazone + 0.70 2,4-D IOE			

Crabgrass		Dandelion		Clover	
Expected	Actual	Expected	Actual	Expected	Actual
70.4	88.4	100.0	100.0	100.0	100.0
70.4	88.9	96.3	100.0	97.5	100.0
70.4	77.8	100.0	100.0	100.0	100.0
70.4	66.7	97.5	100.0	100.0	100.0
85.2	66.7	100.0	100.0	100.0	88.9
85.2	77.8	98.8	100.0	100.0	88.9
80.2	77.8	100.0	100.0	100.0	100.0
80.2	88.9	100.0	100.0	99.7	100.0
80.2	88.4	100.0	100.0	100.0	100.0
80.2	88.9	100.0	100.0	100.0	100.0

Test 2 Control (1-9) 24 HAT				% Control 24 HAT				Treatment					
		Clover											
Crabgrass	Dandelion			Plantain	Crabgrass	Dandelion	Clover	Plantain					
2	2	2	2		22.2	22.2	22.2		Quinclorac @ 0.75 lbs/A				
2	2	2	2		22.2	22.2	22.2		Quinclorac @ 0.375 lbs/A				
3	2	2	2		33.3	22.2	22.2		Quinclorac @ 0.18 lbs/A				
4	2	2	2		44.4	22.2	22.2		Sulfentrazone @ 0.03 lbs/A				
3	2	2	2		33.3	22.2	22.2		Sulfentrazone @ 0.02 lbs/A				
3	3	3	3		33.3	33.3	33.3		2,4-D IOE @ 0.70 lbs/A				
4	3	3	3		44.4	33.3	33.3		0.75 Quinclorac + 0.03 Sulfentrazone				
5	3	5	5		55.6	33.3	55.6		0.75 Quinclorac + 0.02 Sulfentrazone				
5	3	5	5		55.6	33.3	55.6		0.375 Quinclorac + 0.03 Sulfentrazone				
5	3	5	5		55.6	33.3	55.6		0.375 Quinclorac + 0.02 Sulfentrazone				
4	4	4	4		44.4	44.4	44.4		0.18 Quinclorac + 0.03 Sulfentrazone				
5	4	3	3		55.6	44.4	33.3		0.18 Quinclorac + 0.02 Sulfentrazone				
6	5	6	6		66.7	55.6	66.7		0.75 Quinclorac + 0.03 Sulfentrazone + 0.70 2,4-D IOE				
6	5	6	6		66.7	55.6	66.7		0.75 Quinclorac + 0.02 Sulfentrazone + 0.70 2,4-D IOE				
6	5	6	6		66.7	55.6	66.7		0.375 Quinclorac + 0.03 Sulfentrazone + 0.70 2,4-D IOE				
6	5	6	6		66.7	55.6	66.7		0.375 Quinclorac + 0.02 Sulfentrazone + 0.70 2,4-D IOE				

Test 2 Control (1-9) 72 HAT				% Control 72 HAT				Treatment							
Crabgrass	Dandelion	Clover	Plantain	Crabgrass	Dandelion	Clover	Plantain								
4	3	3		44.4	33.3	33.3		Quinclorac @ 0.75 lbs/A							
3	3	3		33.3	33.3	33.3		Quinclorac @ 0.375 lbs/A							
4	5	3		44.4	55.6	33.3		Quinclorac @ 0.18 lbs/A							
3	4	2		33.3	44.4	22.2		Sulfentrazone @ 0.03 lbs/A							
3	4	3		33.3	44.4	33.3		Sulfentrazone @ 0.02 lbs/A							
6	6	6		66.7	66.7	66.7		2,4-D IOE @ 0.70 lbs/A							
				Crabgrass		Dandelion		Crabgrass		Dandelion		Crabgrass		Dandelion	
				Expected	Actual	Expected	Actual	Expected	Actual	Expected	Actual	Expected	Actual	Expected	Actual
7	8	7		77.8	88.9	77.8		0.75 Quinclorac + 0.03 Sulfentrazone							
7	8	6		77.8	88.9	66.7		0.75 Quinclorac + 0.02 Sulfentrazone							
5	8	4		55.6	88.9	44.4		0.375 Quinclorac + 0.03 Sulfentrazone							
6	8	5		66.7	88.9	55.6		0.375 Quinclorac + 0.02 Sulfentrazone							
6	8	4		66.7	88.9	44.4		0.18 Quinclorac + 0.03 Sulfentrazone							
6	8	4		66.7	88.9	44.4		0.18 Quinclorac + 0.02 Sulfentrazone							
8	8	8		88.9	88.9	88.9		0.75 Quinclorac + 0.03 Sulfentrazone + 0.70 2,4-D IOE							
8	8	8		88.9	88.9	88.9		0.75 Quinclorac + 0.02 Sulfentrazone + 0.70 2,4-D IOE							
8	8	8		88.9	88.9	88.9		0.375 Quinclorac + 0.03 Sulfentrazone + 0.70 2,4-D IOE							
8	8	8		88.9	88.9	88.9		0.375 Quinclorac + 0.02 Sulfentrazone + 0.70 2,4-D IOE							

Test 2 Control (1-9) 7 DAT				% Control 7 DAT				Treatment					
Crabgrass	Dandelion	Clover	Plantain	Crabgrass	Dandelion	Clover	Plantain						
7	3	7		77.8	33.3	77.8		Quinclorac @ 0.75 lbs/A					
7	3	7		77.8	33.3	77.8		Quinclorac @ 0.375 lbs/A					
3	8	6		33.3	88.9	66.7		Quinclorac @ 0.18 lbs/A					
2	8	5		22.2	88.9	55.6		Sulfentrazone @ 0.03 lbs/A					
2	8	7		22.2	88.9	77.8		Sulfentrazone @ 0.02 lbs/A					
2	8	6		22.2	88.9	66.7		2,4-D IOE @ 0.70 lbs/A					
				Crabgrass		Dandelion		Clover					
				Expected	Actual	Expected	Actual	Expected	Actual	Expected	Actual	Expected	Actual
8	8	8		82.7	88.9	88.9	88.9	90.1	88.9	90.1	88.9	90.1	88.9
7	8	6		82.7	77.8	88.9	88.9	95.1	88.9	95.1	66.7	95.1	66.7
8	8	8		82.7	88.9	88.9	88.9	90.1	88.9	90.1	88.9	90.1	88.9
6	8	7		82.7	66.7	88.9	77.8	95.1	88.9	95.1	77.8	95.1	77.8
6	8	7		48.1	66.7	88.9	77.8	85.2	88.9	85.2	77.8	85.2	77.8
6	8	7		48.1	66.7	88.9	77.8	92.6	88.9	92.6	77.8	92.6	77.8
8	9	8		86.6	88.9	100.0	88.9	96.7	100.0	96.7	88.9	96.7	88.9
8	9	8		86.6	88.9	100.0	88.9	98.4	100.0	98.4	88.9	98.4	88.9
8	9	8		86.6	88.9	100.0	88.9	96.7	100.0	96.7	88.9	96.7	88.9
8	9	8		86.6	88.9	100.0	88.9	99.2	100.0	99.2	88.9	99.2	88.9



Test 3 Control (1-9) 24 HAT				% Control 24 HAT				Treatment											
Crabgrass	Dandelion	Clover	Plantain	Crabgrass	Dandelion	Clover	Plantain												
1	1	1	1	11.1	11.1	11.1	11.1	11.1 Quinclorac @ 0.75 lbs/A											
1	1	1	1	11.1	11.1	11.1	11.1	11.1 Quinclorac @ 0.375 lbs/A											
1	1	1	1	11.1	11.1	11.1	11.1	11.1 Quinclorac @ 0.18 lbs/A											
1	3	2	4	11.1	33.3	22.2	44.4	Sulfentrazone @ 0.03 lbs/A											
1	3	3	4	11.1	33.3	33.3	44.4	Sulfentrazone @ 0.02 lbs/A											
1	3	4	4	11.1	33.3	44.4	44.4	MCPA IOE @ 1.10 lbs/A											
				Crabgrass		Dandelion		Clover		Plantain									
				Expected	Actual	Expected	Actual	Expected	Actual	Expected	Actual								
1	2	2	4	21.0	11.1	40.7	22.2	30.9	22.2	50.6	44.4								
1	2	2	4	21.0	11.1	40.7	22.2	40.7	22.2	50.6	44.4								
1	2	2	4	21.0	11.1	40.7	22.2	30.9	22.2	50.6	44.4								
1	3	2	5	21.0	11.1	40.7	33.3	40.7	22.2	50.6	55.6								
1	3	3	5	21.0	11.1	40.7	33.3	30.9	33.3	50.6	55.6								
1	3	3	5	21.0	11.1	40.7	33.3	40.7	33.3	50.6	55.6								
1	3	4	5	29.8	11.1	60.5	33.3	61.6	44.4	72.6	55.6								
1	3	3	4	29.8	11.1	60.5	33.3	67.1	33.3	72.6	44.4								
1	3	4	4	29.8	11.1	60.5	33.3	61.6	44.4	72.6	44.4								
1	3	4	4	29.8	11.1	60.5	33.3	67.1	44.4	72.6	44.4								





Test 3 Control (1-9) 7 DAT				% Control 7 DAT				Treatment									
Crabgrass	Dandelion	Clover	Plantain	Crabgrass	Dandelion	Clover	Plantain										
2	2	4	3	22.2	22.2	44.4	33.3	Quinclorac @ 0.75 lbs/A									
2	2	4	3	22.2	22.2	44.4	33.3	Quinclorac @ 0.375 lbs/A									
2	2	4	2	22.2	22.2	44.4	22.2	Quinclorac @ 0.18 lbs/A									
5	6	4	8	55.6	66.7	44.4	88.9	Sulfentrazone @ 0.03 lbs/A									
4	4	3	9	44.4	44.4	33.3	100.0	Sulfentrazone @ 0.02 lbs/A									
1	6	6	6	11.1	66.7	66.7	66.7	MCPA IOE @ 1.10 lbs/A									
				Crabgrass		Dandelion		Clover		Plantain							
				Expected	Actual	Expected	Actual	Expected	Actual	Expected	Actual	Expected	Actual	Expected	Actual	Expected	Actual
6	6	4	9	66.7	66.7	44.4	44.4	100.0	0.75 Quinclorac + 0.03 Sulfentrazone	65.4	66.7	74.1	66.7	69.1	44.4	92.6	100.0
7	6	4	8	77.8	66.7	44.4	88.9	0.75 Quinclorac + 0.02 Sulfentrazone	56.8	77.8	56.8	66.7	63.0	44.4	100.0	88.9	
7	7	4	9	77.8	77.8	44.4	100.0	0.375 Quinclorac + 0.03 Sulfentrazone	65.4	77.8	74.1	77.8	69.1	44.4	92.6	100.0	
6	7	4	8	66.7	77.8	44.4	88.9	0.375 Quinclorac + 0.02 Sulfentrazone	56.8	66.7	56.8	77.8	63.0	44.4	100.0	88.9	
6	6	4	9	66.7	66.7	44.4	100.0	0.18 Quinclorac + 0.03 Sulfentrazone	65.4	66.7	74.1	66.7	69.1	44.4	91.4	100.0	
6	6	4	8	66.7	66.7	44.4	88.9	0.18 Quinclorac + 0.02 Sulfentrazone	56.8	66.7	56.8	66.7	63.0	44.4	100.0	88.9	
8	8	8	9	88.9	88.9	88.9	100.0	0.75 Quinclorac + 0.03 Sulfentrazone + 1.10 MCPA IOE	69.3	88.9	91.4	88.9	89.7	88.9	97.5	100.0	
8	8	8	9	88.9	88.9	88.9	100.0	0.75 Quinclorac + 0.02 Sulfentrazone + 1.10 MCPA IOE	61.6	88.9	85.6	88.9	87.7	88.9	100.0	100.0	
8	8	8	9	88.9	88.9	88.9	100.0	0.375 Quinclorac + 0.03 Sulfentrazone + 1.10 MCPA IOE	69.3	88.9	91.4	88.9	89.7	88.9	97.5	100.0	
8	8	8	9	88.9	88.9	88.9	100.0	0.375 Quinclorac + 0.02 Sulfentrazone + 1.10 MCPA IOE	61.6	88.9	85.6	88.9	87.7	88.9	100.0	100.0	

Test 3 Control (1-9) 14 DAT				% Control 14 DAT				Treatment											
Crabgrass	Dandelion	Clover	Plantain	Crabgrass	Dandelion	Clover	Plantain												
6	4	5	5	66.7	44.4	55.6	55.6	Quinclorac @ 0.75 lbs/A											
4	4	5	4	44.4	44.4	55.6	44.4	Quinclorac @ 0.375 lbs/A											
3	3	4	3	33.3	33.3	44.4	33.3	Quinclorac @ 0.18 lbs/A											
5	7	5	8	55.6	77.8	55.6	88.9	Sulfentrazone @ 0.03 lbs/A											
4	7	4	9	44.4	77.8	44.4	100.0	Sulfentrazone @ 0.02 lbs/A											
2	7	8	7	22.2	77.8	88.9	77.8	MCPA IOE @ 1.10 lbs/A											
7	7	5	9	77.8	77.8	55.6	100.0	0.75 Quinclorac + 0.03 Sulfentrazone		Expected	Actual	Expected	Actual	Expected	Actual	Expected	Actual	Expected	Actual
7	8	5	8	77.8	88.9	55.6	88.9	0.75 Quinclorac + 0.02 Sulfentrazone		85.2	77.8	87.7	77.8	80.2	55.6	95.1	100.0	95.1	100.0
7	8	5	9	77.8	88.9	55.6	100.0	0.375 Quinclorac + 0.03 Sulfentrazone		81.5	77.8	87.7	88.9	75.3	55.6	100.0	88.9	100.0	88.9
7	8	5	9	77.8	88.9	55.6	100.0	0.375 Quinclorac + 0.02 Sulfentrazone		75.3	77.8	87.7	88.9	80.2	55.6	93.8	100.0	100.0	100.0
7	8	5	9	77.8	88.9	55.6	100.0	0.18 Quinclorac + 0.03 Sulfentrazone		69.1	77.8	87.7	88.9	75.3	55.6	100.0	100.0	100.0	100.0
7	8	5	9	77.8	88.9	55.6	100.0	0.18 Quinclorac + 0.02 Sulfentrazone		70.4	77.8	85.2	88.9	75.3	55.6	92.6	100.0	100.0	100.0
7	8	5	9	77.8	88.9	55.6	100.0	0.75 Quinclorac + 0.03 Sulfentrazone + 1.10 MCPA IOE		63.0	77.8	85.2	88.9	69.1	55.6	100.0	100.0	100.0	100.0
8	8	8	9	88.9	88.9	88.9	100.0	0.75 Quinclorac + 0.02 Sulfentrazone + 1.10 MCPA IOE		88.5	88.9	97.3	88.9	97.8	88.9	98.9	100.0	98.9	100.0
8	8	8	9	88.9	88.9	88.9	100.0	0.375 Quinclorac + 0.03 Sulfentrazone + 1.10 MCPA IOE		85.6	88.9	97.3	88.9	97.3	88.9	100.0	100.0	100.0	100.0
8	8	8	9	88.9	88.9	88.9	100.0	0.375 Quinclorac + 0.02 Sulfentrazone + 1.10 MCPA IOE		80.8	88.9	97.3	88.9	97.8	88.9	98.6	100.0	98.6	100.0
8	8	8	9	88.9	88.9	88.9	100.0	0.375 Quinclorac + 0.02 Sulfentrazone + 1.10 MCPA IOE		76.0	88.9	97.3	88.9	97.3	88.9	100.0	100.0	100.0	100.0

Test 3					Control (1-9)				21 DAT				% Control 21 DAT				Treatment								
Crabgrass		Dandelion		Clover	Plantain	Crabgrass	Dandelion	Clover	Plantain	Crabgrass	Dandelion	Clover	Plantain												
7	3	8	5			77.8	33.3	88.9	55.6	Quinclorac @ 0.75 lbs/A															
6	5	8	4			66.7	55.6	88.9	44.4	Quinclorac @ 0.375 lbs/A															
3	3	6	3			33.3	33.3	66.7	33.3	Quinclorac @ 0.18 lbs/A															
4	7	5	9			44.4	77.8	55.6	100.0	Sulfentrazone @ 0.03 lbs/A															
3	6	4	9			33.3	66.7	44.4	100.0	Sulfentrazone @ 0.02 lbs/A															
4	8	9	7			44.4	88.9	100.0	77.8	MCPA IOE @ 1.10 lbs/A															
7	9	6	9			77.8	100.0	66.7	100.0	0.75 Quinclorac + 0.03 Sulfentrazone															
7	9	5	9			77.8	100.0	55.6	100.0	0.75 Quinclorac + 0.02 Sulfentrazone															
7	8	7	9			77.8	88.9	77.8	100.0	0.375 Quinclorac + 0.03 Sulfentrazone															
7	8	6	9			77.8	88.9	66.7	100.0	0.375 Quinclorac + 0.02 Sulfentrazone															
7	8	7	9			77.8	88.9	77.8	100.0	0.18 Quinclorac + 0.03 Sulfentrazone															
7	8	6	9			77.8	88.9	66.7	100.0	0.18 Quinclorac + 0.02 Sulfentrazone															
8	9	9	9			88.9	100.0	100.0	100.0	0.75 Quinclorac + 0.03 Sulfentrazone + 1.10 MCPA IOE															
8	8	9	9			88.9	88.9	100.0	100.0	0.75 Quinclorac + 0.02 Sulfentrazone + 1.10 MCPA IOE															
8	9	9	9			88.9	100.0	100.0	100.0	0.375 Quinclorac + 0.03 Sulfentrazone + 1.10 MCPA IOE															
8	9	9	9			88.9	100.0	100.0	100.0	0.375 Quinclorac + 0.02 Sulfentrazone + 1.10 MCPA IOE															

Test 4 Control (1-9) 24 HAT				% Control 24 HAT				Treatment											
Crabgrass	Dandelion	Clover	Plantain	Crabgrass	Dandelion	Clover	Plantain												
1	1	1	1	11.1	11.1	11.1	11.1	Quinclorac @ 0.75 lbs/A											
1	2	1	1	11.1	22.2	11.1	11.1	Quinclorac @ 0.375 lbs/A											
1	1	1	1	11.1	11.1	11.1	11.1	Quinclorac @ 0.18 lbs/A											
1	3	4	3	11.1	33.3	44.4	33.3	Carfentrazone @ 0.02 lbs/A											
1	2	2	3	11.1	22.2	22.2	33.3	Carfentrazone @ 0.01 lbs/A											
1	3	4	2	11.1	33.3	44.4	22.2	MCPA IOE @ 1.10 lbs/A											
1	3	4	4	11.1	33.3	44.4	44.4	0.75 Quinclorac + 0.02 Carfentrazone		21.0	11.1	40.7	33.3	50.6	44.4	40.7	44.4		
1	3	3	4	11.1	33.3	33.3	44.4	0.75 Quinclorac + 0.01 Carfentrazone		21.0	11.1	30.9	33.3	30.9	33.3	40.7	44.4		
1	3	3	5	11.1	33.3	33.3	55.6	0.375 Quinclorac + 0.02 Carfentrazone		21.0	11.1	48.1	33.3	50.6	33.3	40.7	55.6		
1	3	3	4	11.1	33.3	33.3	44.4	0.375 Quinclorac + 0.01 Carfentrazone		21.0	11.1	39.5	33.3	30.9	33.3	40.7	44.4		
1	3	3	4	11.1	33.3	33.3	44.4	0.18 Quinclorac + 0.02 Carfentrazone		21.0	11.1	40.7	33.3	50.6	33.3	40.7	44.4		
1	3	3	5	11.1	33.3	33.3	55.6	0.18 Quinclorac + 0.01 Carfentrazone		21.0	11.1	30.9	33.3	30.9	33.3	40.7	55.6		
1	3	5	4	11.1	33.3	55.6	44.4	0.75 Quinclorac + 0.02 Carfentrazone + 1.10 MCPA IOE		29.8	11.1	60.5	33.3	72.6	55.6	53.9	44.4		
1	4	5	5	11.1	44.4	55.6	55.6	0.75 Quinclorac + 0.01 Carfentrazone + 1.10 MCPA IOE		29.8	11.1	53.9	44.4	61.6	55.6	53.9	55.6		
1	4	5	5	11.1	44.4	55.6	55.6	0.375 Quinclorac + 0.02 Carfentrazone + 1.10 MCPA IOE		29.8	11.1	65.4	44.4	72.6	55.6	53.9	55.6		
1	4	5	5	11.1	44.4	55.6	55.6	0.375 Quinclorac + 0.01 Carfentrazone + 1.10 MCPA IOE		29.8	11.1	59.7	44.4	61.6	55.6	53.9	55.6		

Test 4 Control (1-9) 72 HAT				% Control 72 HAT				Treatment																
Crabgrass	Dandelion	Clover	Plantain	Crabgrass	Dandelion	Clover	Plantain																	
2	2	2	3	22.2	22.2	22.2	33.3	Quinclorac @ 0.75 lbs/A																
1	2	2	2	11.1	22.2	22.2	22.2	Quinclorac @ 0.375 lbs/A																
1	2	2	2	11.1	22.2	22.2	22.2	Quinclorac @ 0.18 lbs/A																
4	5	4	6	44.4	55.6	44.4	66.7	Carfentrazone @ 0.02 lbs/A																
2	3	4	8	22.2	33.3	44.4	88.9	Carfentrazone @ 0.01 lbs/A																
1	5	5	4	11.1	55.6	55.6	44.4	MCPA IOE @ 1.10 lbs/A																
3	5	5	8	33.3	55.6	55.6	88.9	0.75 Quinclorac + 0.02 Carfentrazone																
3	5	5	8	33.3	55.6	55.6	88.9	0.75 Quinclorac + 0.01 Carfentrazone																
5	5	4	8	55.6	55.6	44.4	88.9	0.375 Quinclorac + 0.02 Carfentrazone																
3	5	4	8	33.3	55.6	44.4	88.9	0.375 Quinclorac + 0.01 Carfentrazone																
5	5	5	8	55.6	55.6	55.6	88.9	0.18 Quinclorac + 0.02 Carfentrazone																
4	6	5	8	44.4	66.7	55.6	88.9	0.18 Quinclorac + 0.01 Carfentrazone																
6	6	6	8	66.7	66.7	66.7	88.9	0.75 Quinclorac + 0.02 Carfentrazone + 1.10 MCPA IOE																
5	6	6	8	55.6	66.7	66.7	88.9	0.75 Quinclorac + 0.01 Carfentrazone + 1.10 MCPA IOE																
6	7	6	8	66.7	77.8	66.7	88.9	0.375 Quinclorac + 0.02 Carfentrazone + 1.10 MCPA IOE																
5	7	6	8	55.6	77.8	66.7	88.9	0.375 Quinclorac + 0.01 Carfentrazone + 1.10 MCPA IOE																



